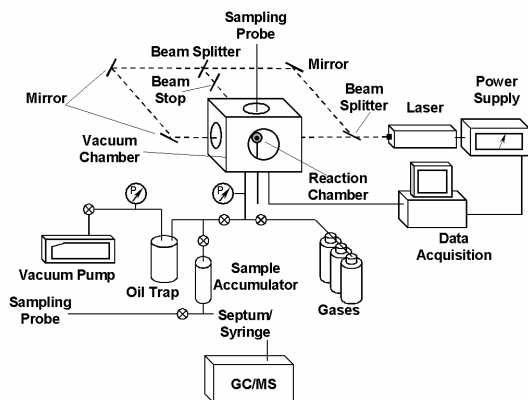


Absorption Coefficient Measurements of Carbonaceous-Based Aerosol Particles

It is well known that atmospheric aerosols, e.g., particulate matter and cloud condensation nuclei, have a large, but quantitatively unknown, effect on the radiative forcing of the atmosphere. Carbonaceous aerosols (i.e., organic and black carbon) make up a large but highly variable fraction of the atmospheric aerosols. Often, present day models of aerosols implicitly include empirically determined values for the absorption coefficient. These models will be improved by explicit measurements of the effects of mixing black carbon with other aerosols to reduce uncertainties. A laser-based approach is being used at to measure the absorption coefficient of a variety of carbonaceous-based material.

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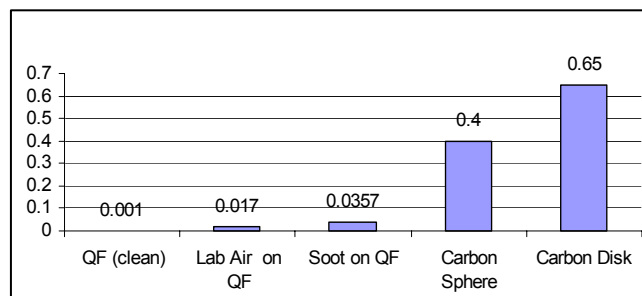
Carbonaceous aerosol scattering of radiation (e.g., from smoldering combustion) can lead to surface cooling, while absorption (e.g. from high-temperature combustion) can result in atmospheric warming. Modelers use any available information on aerosol optical properties to infer values for radiative forcing. The purpose of this research was to study the feasibility of using a new measurement approach to determine the absorption coefficient of carbonaceous-based aerosol particles, using controlled laser heating. This research team is using a laser-based approach, referred to as the laser-driven thermal reactor (LDTR) (see schematic diagram below), to provide the necessary temporal and thermal response to measure the absorption coefficient of a variety of carbonaceous-based material. To date, we have conducted measurements using clean quartz-fiber filters, filters exposed to laboratory air particles and soot, and pre-shaped activated carbon (spheres and disk-shaped pellets).



Measurements were carried out in the LDTR to determine the effect of carbon shape and size on its absorption characteristics. This information is important for characterizing particles when their surface is not spherical and well

predicted by theory. Results were obtained for a spherical and disk-shape agglomerates of compacted particles over a range of laser heating temperatures.

The graph compares the absorptivity (fraction of incident radiation absorbed) measured from different materials at a sample temperature of 300 K.



The figure displays several trends. The activated carbon disk provided an upper limit for absorptivity due to the direct laser beam impingement on the disk flat surface, while the clean quartz-fiber filters were, as expected, essentially nonabsorbing. The result for the activated carbon spheres indicates that particle shape has an important effect. The same trends also are found at higher sample temperatures.

The measurement of the optical absorption of aerosol particles with greater accuracy than other techniques may improve the performance of thermal-optical analyzers, which are used extensively to characterize aerosol particles that are collected in the atmosphere. In addition, climate models that predict the global average temperature require reliable data on the absorption coefficient of particulate matter, but detailed information on their optical properties is largely unavailable.

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Future Plans: We plan to use this technique to develop a unique database that includes, in addition to soot absorption coefficient, other optical and physical properties for soot, other representative samples of particulate matter, and multiphase and multi-component liquid droplets that are representative of cloud condensation nuclei characteristics. These data will provide input information for climate change models, and will improve the performance of optical instruments that monitor particulate matter in the environment